Lung Cancer:

Causes and Prevention

Proceedings of the International Lung Cancer Update Conference, held in New Orleans, Louisiana, March 3-5, 1983

Edited by

Merle Mizell and **Pelayo Correa**

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aid of the student members of AED and their antismoking efforts; as well as the help of Diana Pinckley, Director of Tulane University Relations, and her efficient staff for their aid in cover design and various aspects of production. The organizers of the conference are especially indebted to Lorraine Mizell, whose untiring work helped make the meeting a success and whose continuing efforts and administrative expertise helped produce this monograph.

The conclusion is clear: cigarette smoking causes lung cancer. If scientists and concerned citizens can communicate that simple message to the public, the cigarette advertising salvos and lobbying efforts may all be for naught. There will then be hope of controlling this disease.

Merle Mizell, PhD
Pelayo Correa, MD

To

Alton Ochsner, MD

It is fitting that this conference is dedicated to my father, Alton Ochsner, since at one time he stood alone in the belief that smoking was a cause of carcinoma of the lung. It was a stand from which he never swayed, despite the criticism he suffered from his colleagues.

My father fought furiously for that which he believed and yet was willing to change if proved wrong. In looking through his bibliography the other day, I came across an editorial he wrote in 1937 in Surgery, Gynecology & Obstetrics, *entitled "Empiricism in Medicine." In this editorial he stated that Galen's teaching that "pus was laudable" was observed empirically for centuries before doctors realized that pus was not laudable. Because of the adherence to Galen's teaching, many died unnecessarily and others bore pain, suffering, and disfiguration beyond belief. The editorial emphasized to me that my father always taught that one must learn and change with time. He first suggested in 1936 that smoking was a cause of cancer of the lung and championed this hypothesis for years, despite the fact that he was ridiculed by some of his peers: at a particular national meeting when he projected a slide which showed the incidence of carcinoma of the lung and sales of cigarettes having a parallel graph, another surgeon superposed on his slide the sales of brassieres to mock his theory.*

Dr. Evarts Graham, his Professor of Surgery at Washington University and who later became as adamant as my father as an antismoking crusader, told my father, "You are going to crucify yourself if you continue to say there is a relationship between cancer of the lung and smoking. The medical profession will think you are nuts." Many years later when Dr. Graham developed cancer of the lung, he wrote to my father and stated that he wished he had listened to him, for had he done so, he would certainly have lived longer.

Although my father was dogmatic in certain spheres, his mind was flexible enough to change when statistics proved him wrong. He championed pneumonectomy as the treatment for cancer of the lung, feeling that in order to have an adequate cancer operation, one had to remove the entire organ. He felt this so strongly that if he performed a minor resection of a lung tumor which at surgery appeared to be benign and yet on histological examination proved to be malignant, he would return the patient to the operating room and do a radical pneumonectomy. When the statistics of Dr. William Overholt showed that treatment of cancer of the lung was equally as good with lobectomy as with pneumonectomy, Dad was prompt in changing his teaching and accepted lobectomy as the principal means of eradicating cancer of the lung.

People remember this man as a scholar, innovator, teacher, and exceptional civic leader.

John Ochsner, MD, Chairman
Department of Surgery
Ochsner Clinic

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Preface

. The main cause of lung cancer is cigarette smoking; about that the scientific work reported in this book leaves no doubt. Approximately 90% of the deaths from lung cancer and almost one-third of the deaths from cancer of all kinds can be traced directly to smoking. In 1982, about 129,000 Americans died from smoking-related cancers, according to estimates from the Office of Smoking of the U.S. Department of Health and Human Services. But cancer is not the only disease smokers have to fear: the habit also causes elevated rates of heart disease.

According to research reported in this volume, about one in four regular cigarette smokers will be killed before their time by the habit. And the magnitude of the problem is greater than usually is realized. Of every 100 healthy young male smokers in England, statistics predict that one will die a victim of violent crime, two will be killed in traffic accidents, and 25 will die from a disease brought about by cigarettes. Similar proportions of deaths will occur in the United States. Women are quickly gaining equality with men in the lung cancer arena: in 1982, lung cancer surpassed breast cancer as the leading cause of cancer deaths among women in eight states. The pattern, which is believed to be nationwide, is attributed to an increase in smoking which began among women 30 years ago.

The cost for smokers is high in terms of dollars as well as health. In Louisiana, where 2,100 persons die every year from lung cancer, more than $300 million annually are spent on the purchase of cigarettes and medical costs and loss of earnings account for approximately $586 million per year. The state—especially its southern area—has one of the highest cancer rates in the nation, and many of the studies in this volume look at some of the reasons.

Several papers demonstrate that smoking no longer can be considered a personal habit concerning only smokers. Passive smoking—smoke inhaled from nearby smokers—increases the lung cancer rate. Research conducted in Japan has demonstrated that nonsmoking wives of heavy smokers suffer a lung cancer risk at least twice as great as nonsmoking wives of nonsmoking husbands. Research has also shown that radioactive materials are a common component of cigarette smoke. Other studies in the book explore the relationships of nutrition, smoking, and lung cancer: a precursor of vitamin A that comes from green and yellow vegetables can perhaps lower cancer risks. Smoking can work synergistically with occupational exposure to cancer-inducing agents to increase dramatically the risk of lung cancer. Studies have shown that some individuals may have genetic factors that make them more susceptible to certain environmental carcinogens.

Contents

Cigarette smoking is a form of drug dependence because nicotine is an addiction-causing drug. And cigarette smoking is *known* to cause cancer. The addiction to this toxic drug produces many times more deaths than addictions to marijuana, morphine, and cocaine combined. Yet those drugs are illegal. Why then, one may ask, are cigarettes advertised and sold all over the world? When cigarette addiction began about 60 years ago, its deleterious effects on health were not known because smoking-induced cancers can take as long as 30 years to develop. Now, cigarettes are a multibillion dollar industry with extremely well-organized lobbies and advertising efforts. Well over $1 billion each year are spent on efforts to promote this addictive and deadly drug; that sum is more than the total budget of the National Cancer Institute.

What can be done? Some of the research in this volume explores the alternatives. Abolishing smoking, of course, is unrealistic, but other efforts hold promise. Reducing tar in cigarettes may, over the years, reduce cancer rates, but in absolute numbers, lung cancer deaths are likely to go on increasing well into the twenty-first century due to saturation marketing efforts and increases in absolute numbers of smokers. Public education efforts about the deadly effects of smoking are inadequate at the present time and could be made much more effective. And legislation—with higher taxes—can make a difference. In Finland ambitious new laws were enacted in 1977: these laws prohibited advertising and sales promotion of cigarettes; forbade smoking in all public places except in designated areas; outlawed the sale of tobacco products to persons under 16 years of age; reserved money from tobacco tax revenue for developing health-oriented government tobacco policy; and made the government responsible for establishing the limits of harmful components in tobacco products. Finland now leads the world in reducing lung cancer deaths, especially in younger individuals.

The best way to change smoking patterns, which would automatically affect lung cancer occurrence, is to convince young people never to begin smoking. Parents must be aware of their responsibilities as role models and schools should make a health education program emphasizing the hazards of smoking a part of instruction from kindergarten through college.

The college students from Tulane's Chapter of Alpha Epsilon Delta, recognizing the hazards of smoking, helped with various phases of the conference and continue to sponsor antismoking activities. In fact, plans for this book began when Alton Ochsner became an honorary member of AED (the National Pre-Medical Honor Society). We were seated around a banquet table in a New Orleans garden district restaurant when the International Lung Cancer Update Conference was first discussed. Dr. Ochsner planned to present a short history of lung cancer at the conference, for as he told us ". . . . . this disease has grown up with me. It did not exist when I was a medical student." Unfortunately Alton Ochsner died before the conference convened, so this volume lacks his historical perspective. Nevertheless, this book is dedicated to the memory of Alton Ochsner and we were pleased to have his son, John Ochsner, participate in his stead. We gratefully acknowledge the continuing

recognized as possibly the most important work-related cancer. However, the interaction between smoking and occupational exposures and the increased risk that may be attributed to an occupational exposure has not been very well characterized for a large number of workplace exposures.

A population-based case-comparison interview study of lung cancer, obtaining detailed occupational histories, was conducted in six Texas coastal counties where lung cancer mortality rates were elevated (3). Figure 1 shows the location of the counties of Orange, Jefferson, Chambers, Brazoria, Galveston, and Harris, a highly industrialized area where Houston is located. Approximately 25% (3.5 million) of the total state population in 1980 resided in this southeastern coastal area, the majority (77.5%) in Harris County.

Newly diagnosed, histologically confirmed cases of lung cancer in white females (including Hispanic) were ascertained from July 1977 through June 1980 in Harris County (3 years) and from July 1976 through June 1980 for the surrounding five counties. Similarly, cases among white males (including Hispanic) were ascertained for four years (July 1976 through June 1980) for the five less urban but industrialized counties, excluding Harris County. Background lung cancer mortality rates for white males and females were examined by Texas State Economic Area

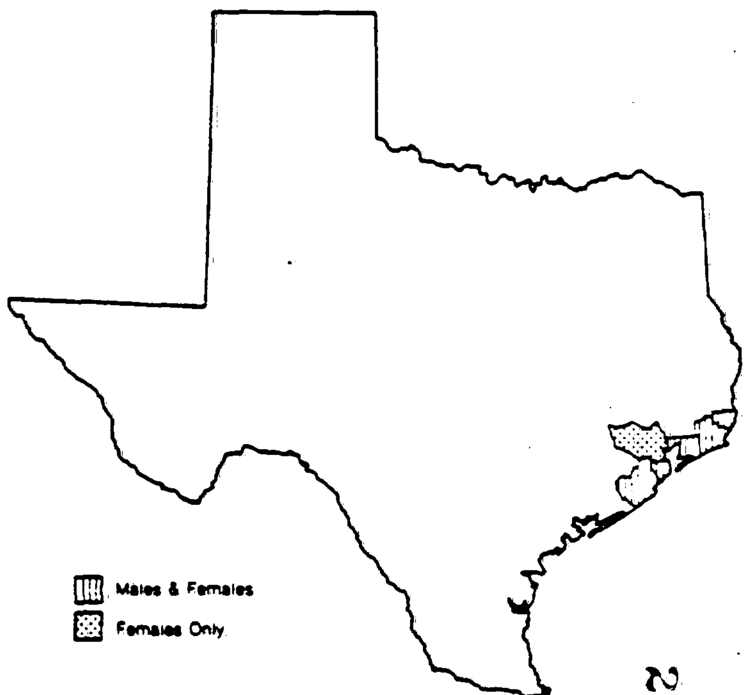

Figure 1. Texas lung cancer study area.

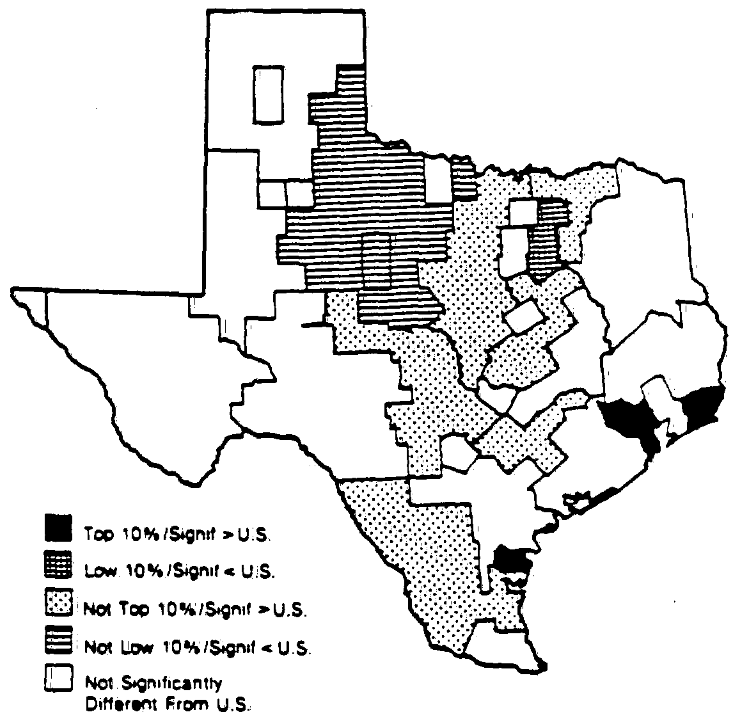

Figure 3. Lung cancer mortality 1970–1975 for white females.

petrochemical manufacturing, petroleum refining, construction, and metal industries. The largest United States based chemical and synthetic rubber production facilities are located in the study area, so a high proportion of the working population currently is employed or has been employed in these industries. For some of the smaller counties, such as Orange and Jefferson, where a single industry is dominant, as high as 27% of the working population reported being currently employed in chemical and allied products manufacturing compared with 2% for Harris County (5).

Methods

Histologically confirmed incident cases of lung cancer diagnosed among white male and female residents (including Hispanic) of the study counties for the designated time intervals (July 1977 through June 1980 for females in Harris County and July 1976 through June 1980 for males and females in other counties) were ascertained by review of hospital and state records. Hospitals in the study area that were not already participating in the Statewide Cancer Reporting Program

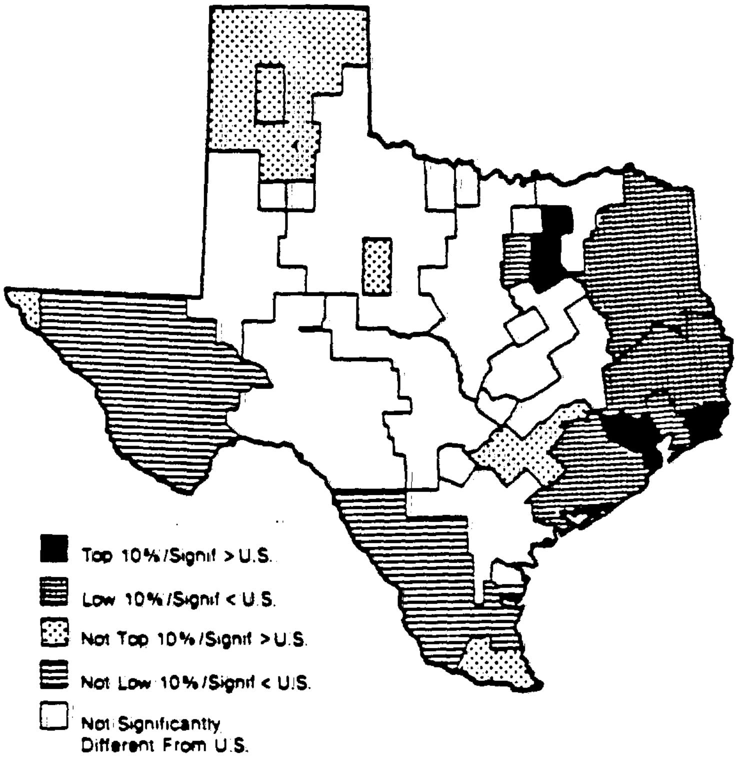

Figure 2. Lung cancer mortality 1970–1975 for white males.

(SEA) for the time period (1970 to 1975[1]) immediately preceeding the case-comparison study. As shown in Figures 2 and 3, these maps consistently document the significantly higher lung cancer mortality rates observed earlier for both white males and white females in these Texas coastal counties. The dark areas along the upper Texas coast are the Beaumont SEA (Orange and Jefferson counties), the Houston SEA (Harris County), and the Galveston SEA (Galveston County). Age-adjusted mortality rates (adjusted to the 1960 United States population) in these areas are in the top 10% of rates for SEAs in the United States and are significantly higher than the white male or white female lung cancer mortality rate for the total United States population. For white females in Harris County, this excess was notable for both the rate and the trend in the rate from 1950 to 1975 (4). For all ages, combined, the overall excess in lung cancer mortality in the Texas study area is approximately 30–40%, but this is considerably greater for some age groups.

Occupational and industrial exposures of importance for residents of the Texas coastal area include those associated with shipbuilding and repair, chemical and

[1] Excluding deaths for 1972.

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The Causes of Lung Cancer in Texas

PATRICIA A. BUFFLER,* LINDA WILLIAMS PICKLE,** THOMAS J. MASON,** and CHARLES CONTANT**

* Epidemiology Research Unit, The University of Texas Health Science Center at Houston, School of Public Health, Houston, Texas 77025
**Environmental Epidemiology Branch, National Cancer Institute, Landow 3C15, Bethesda, Maryland 20205

ABSTRACT

A population-based case-comparison interview study of lung cancer was conducted from 1979 to 1982 in six Texas coastal counties—Orange, Jefferson, Chambers, Harris, Galveston, and Brazoria—to evaluate the association of lung cancer with occupational and other environmental exposures. Lung cancer mortality rates in these counties consistently have exceeded lung cancer mortality rates observed for Texas and the United States from 1950–1969 to 1970–1975 for both sexes and races (white and nonwhites).

Histologically and cytologically confirmed incident cases diagnosed during the interval July 1976 to June 1980 among white male and female residents aged 30–79 years were ascertained from participating hospitals in the six-county area. Both population-based and decedent comparisons were selected and matched on age, race, sex, region of residence, and vital status at time of ascertainment.

The exposures of primary interest in the study of lung cancer are those associated with occupation (employment in specific industries and occupations) in conjunction with tobacco, alcohol, diet, and residential exposures.
Key Words: Smoking history, petrochemical industry, histologic types, construction workers, chemical manufacturing, transportation

Introduction and Background

Data presented by Doll and Peto (1) and related reports (2) indicate that respiratory cancer sites, dominated by lung cancer, show the most dramatic increases of all cancer sites over the past 30 years. The role of smoking in the etiology of respiratory cancer has been well documented. In addition, lung cancer is

As a result of bringing the world's authorities on lung cancer research together in New Orleans to present and exchange research findings about the state of the art in this field, the world has seen that Louisiana is seriously concerned about this dread disease and intends to promote scientific research in order to address this problem. Therefore the state's image with the scientific community has been enhanced worldwide.

Louisiana's citizens have benefited from this conference because they received the most current and reputable advice from the foremost experts in the field about what they can do to enhance their chances of living lung-cancer-free lives. They learned that this disease is largely self-inflicted.

Finally the scholars, scientists, and medical practitioners in Louisiana's institutions of higher learning, as well as the scientific community outside our colleges and universities, have benefited from the opportunity to exchange information with, ask questions of, and interact with the experts who participated in this conference.

The International Lung Cancer Update Conference was a tremendous success, and we at the Board of Regents are extremely pleased to have been a part of it.

William Arceneaux, PhD
Commissioner of Higher Education
Louisiana Board of Regents

Sponsoring a conference is an uncommon event for the Louisiana Board of Regents' Research and Development Program. Generally only research projects which address issues that are of particular concern to the state (eg, hazardous waste, economic development, wetlands, the state's high incidence of cancer) are supported with these state-appropriated funds. Since one of the goals of this program, however, is to upgrade the quality of research in Louisiana's institutions of higher learning, the Board of Regents and its Advisory Committee on Research and Development decided that sponsorship of this conference not only was appropriate, but also would be a decided investment in the future of quality cancer research in the state.

In sponsoring this conference, the state provided its scientists a rare and perhaps unique opportunity to learn from and exchange ideas with the world's foremost authorities in the lung cancer field in a convenient location and forum. The knowledge and information the state's scientists gleaned as a result of this conference should stimulate interest in this area, as well as promote the submission of research applications to the R&D Program that are at the forefront of knowledge in this field.

The response to this conference from the Louisiana scientific and medical communities was overwhelmingly positive. The Board of Regents was fortunate that the organizers of the conference were responsible and talented individuals who undertook this task in a serious and dedicated manner. Their hard work and combined talents, in conjunction with the outstanding speakers and excellent scientific presentations, made the conference an unequivocal success. On behal

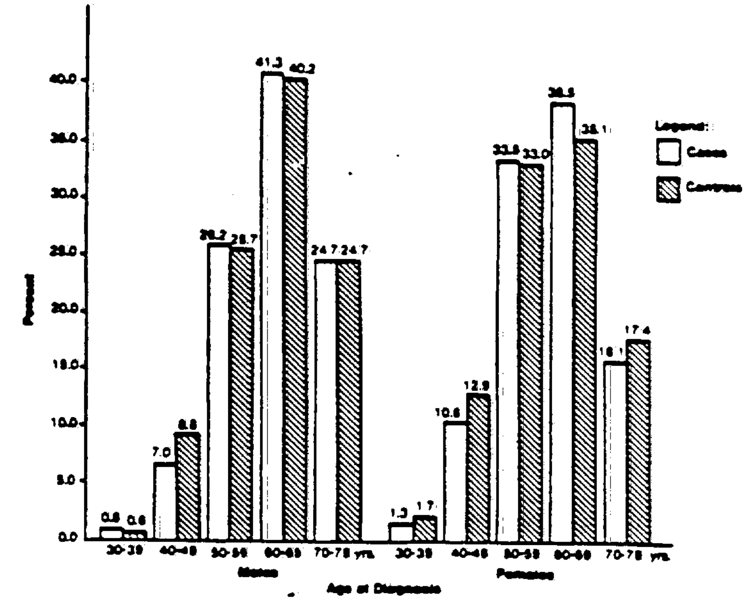

Figure 4. Age distribution (age at diagnosis) for male and female study subjects, Texas lung cancer study, 1976–1980. Clear columns, cases; shaded columns, controls.

cumulated lifetime cigarette dose, expressed as pack-years, were higher for males in the low and moderate categories but associated with a similar gradient in both males and females. No difference in risk was associated with the use of filtered cigarettes for either males or females.

The role of "passive smoking" in contributing to risk of lung cancer was examined (Table 7). In this analysis the crude (or unadjusted) odds ratio are increased and significant for both males and females, 1.4 and 2.1, respectively. However, when the confounding effect of individual subject smoking was controlled by stratifying the

Table 5. Proportion of cases and controls reporting use of tobacco, cigarettes and alcohol by sex, Texas lung cancer study, 1976–1980

	Males		Females	
	Cases	Controls	Cases	Controls
Tobacco (ever)	0.99	0.90	0.91	0.59
Cigarettes (ever)	0.97	0.80	0.91	0.59
Cigarettes (current)	0.54	0.47	0.68	0.38
Cigarettes (light)	0.08	0.10	0.08	0.17
Cigarettes (heavy)	0.45	0.29	0.34	0.13
Alcohol (ever)	0.86	0.81	0.78	0.63
Lived with a smoker	0.76	0.70	0.93	0.88

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Acknowledgments

I speak on behalf of Tulane Medical Center when I say that we are pleased and proud that Tulane University has served as one of the cosponsoring universities of this International Lung Cancer Update Conference.

It is fitting that this monograph be dedicated to the memory of Alton Ochsner, MD, an honorary alumnus of Tulane School of Medicine. He served on the Tulane faculty for many years as professor and chairman of surgery, prior to establishing along with four other Tulane department heads what has become the Alton Ochsner Medical Foundation. Dr. Ochsner, an internationally known surgeon, dedicated his life to the elimination of lung cancer.

We have come far in the battle against lung cancer, but there is still much more we can learn about the etiology, prevention, treatment, and ultimately the elimination of lung cancer as a significant cause of human suffering. It is through participation in cooperative efforts such as this international conference that we hope to provide an exchange of information which will lead to even more answers about lung cancer.

John J. Walsh, MD, Chancellor
Tulane University Medical Center

I am glad to acknowledge the success of the joint efforts of our institutions: Louisiana State University, Tulane University, Cancer Association of Greater New Orleans, and the Board of Regents in organizing and carrying out the International Lung Cancer Update Conference.

The conference addressed an issue of great importance to our community and provided up-to-date presentations by some of the best international experts in the field. The conference has already stimulated important discussions in our scientific community and has established an objective scientific basis to approach the lung cancer problem in our state. I hope the impetus provided by the conference will continue until a strategy for prevention is developed.

Paul F. Larson, MD, Dean
Louisiana State University
School of Medicine in New Orleans

The Louisiana Board of Regents and its Advisory Committee on Research and Development are pleased to have had the opportunity to sponsor the International Lung Cancer Update Conference. The state of Louisiana, its citizens, and its institutions of higher learning are all beneficiaries of this meeting.

Table 1. Lung cancer case ascertainment in Texas study by sex, ethnic group, and area, 1976–1980

	Number estimated	Number ascertained[a] (%)	Number cases interviewed[b]
White Females			
Anglo	822	750 (91.2)	449
Spanish surname	42	16 (38.1)	11
Total	864	766 (88.7)	460
White Males			
Anglo	767	730 (95.2)	460
Spanish surname	18	24 (133.3)	15
Total	785	754 (96.1)	475
Area			
Harris County (females only, 1977–1980)	567	468 (82.1)	275
Other counties	1082	1052 (97.2)	660
Total	1649	1520 (92.2)	935

[a] Includes 110 cases without histologic confirmation and an additional 15 cases estimated to be ineligible, in terms of race and residence criteria

[b] Excludes cases ineligible, not located, refusals by physician, hospital or study subject, and cases interviewed and subsequently identified as ineligible, or data to be of poor quality

Table 2. Texas lung cancer study population by sex, study group, and ethnicity

	Study group		
	Cases	Controls	Totals
Total			
Female	460	482	942
Male	475	466	941
Total	935	948	1883
Spanish surname			
Female	11	20	31
Male	15	19	34
Total	26	39	65

hospital, and subject refusals; and poor quality interview data. Overall study subject refusal rates were 7.7% and 10.7% for decedent cases and controls respectively, and 13.5% and 20.6% for living cases and controls, respectively. A total of 935 interviews was completed with eligible cases (460 females and 475 males) and 948 interviews with frequency matched comparison subjects (Table 2). Included in these totals are 26 Spanish surname cases and 39 comparison subjects. Separate analyses are not presented at this time for these study subjects.

The average duration of time study subjects resided in the county of diagnosis or in the six-county study area is over 25 years for all study groups. The majority of both male (86%) and female (82%) cases were decedent cases and were slightly older at time of diagnosis than the living cases (Tables 3 and 4). The distribution of age at diagnosis is compared for male and female study groups in Figure 4. A higher proportion of the female cases was diagnosed before age 60 (45.4%) than male cases diagnosed before age 60 (34%).

Table 3. Number and percentage of male lung cancer cases by age at diagnosis and type of respondent, Texas, 1976 to 1980

Age at diagnosis (years)	Type of respondent								Total			
	Self				Next of kin							
	Cases		Controls		Cases		Controls		Cases		Controls	
	No	%	No	%	No	%	No	%	No	%	No	%
30-39	1	1.5	1	1.6	3	0.7	2	0.5	4	0.8	3	0.6
40-49	5	7.5	7	10.9	28	6.9	34	8.5	33	7.0	41	8.8
50-59	23	34.3	22	34.4	102	25.0	98	24.4	125	26.2	120	25.7
60-69	31	47.0	23	35.9	165	40.4	164	40.8	196	41.3	18.7	40.2
70-79 +	7	10.6	11	17.2	110	27.0	104	25.9	117	24.7	11.5	24.7
		100.0		100.0		100.0		100.0		100.0		100.0
Totals	67		64		408		402		475		466	

Table 4. Number and percentage of female lung cancer cases by age at diagnosis and type of respondent, Texas, 1976 to 1980

Age at diagnosis (years)	Type of respondent								Total			
	Self				Next of kin							
	Cases		Controls		Cases		Controls		Cases		Controls	
	No	%	No	%	No	%	No	%	No	%	No	%
30-39	0	0.0	3	2.6	6	1.6	5	1.4	6	1.3	8	1.7
40-49	9	11.1	12	10.3	40	10.6	50	13.7	49	10.6	62	12.9
50-59	36	44.4	55	47.4	118	31.1	104	28.4	154	33.5	159	33.0
60-69	24	29.6	34	29.3	153	40.4	135	36.9	177	38.5	169	35.1
70-79 +	12	14.8	12	10.3	62	16.4	72	19.7	74	16.1	84	17.4
		100.0		100.0		100.0		100.0		100.0		100.0
Totals	81		116		379		366		460		482	

Proportions of male and female cases and comparison subjects using tobacco, cigarettes, alcohol, or who "ever lived with household member who smoked regularly" are compared in Table 5. Ninety-seven percent of the male cases and 91% of the female cases reported ever smoking cigarettes but a higher proportion of the female than male cases reported smoking cigarettes currently, 68% vs 54%. Proportions of heavy smokers and use of alcohol (ever) were higher for cases than comparison subjects and for males than females. An extremely high proportion of both female cases and comparison subjects report having lived with a household member who smoked regularly, 93% vs 88%.

Although the patterns of risk differed for males and females (Table 6), the odds ratios for all smoking variables were statistically significant at the $p = .05$ level. Among males, ex-smokers had a risk higher than current smokers, whereas in females the risk was lower in ex-smokers. The highest odds ratio for females was observed for current smokers, 7.9 vs 5.0 for ex-smokers. Odds ratios for the ac-

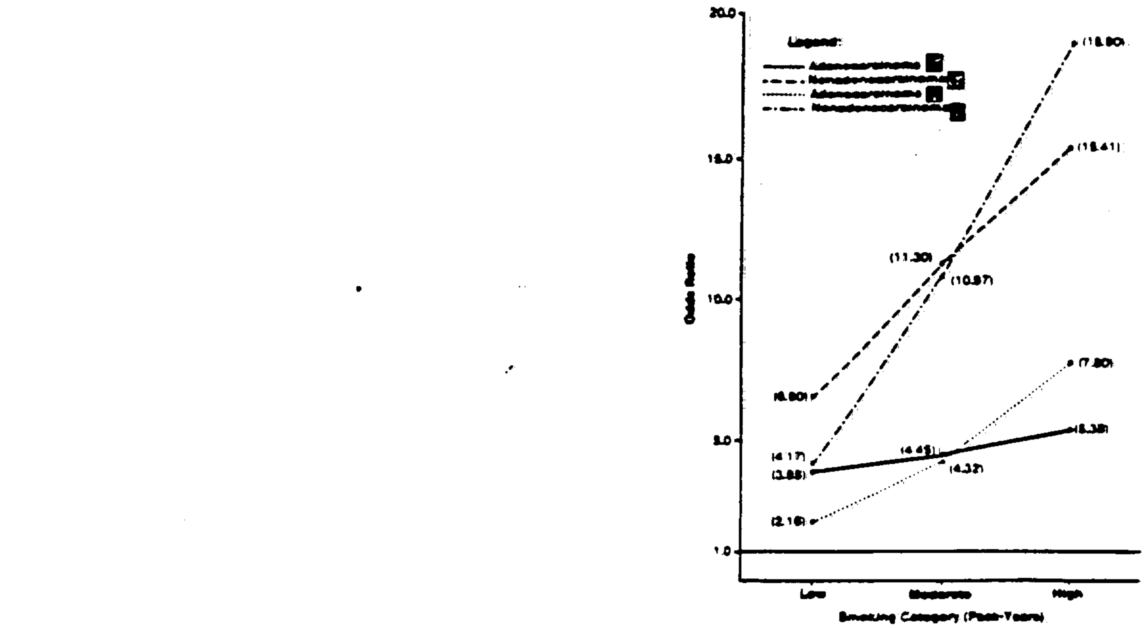

Figure 5. Odds ratios associated with smoking by lung cancer cell type.

The majority (approximately 60%) of the females reported their usual occupation as housewife. Using this category as the referent (OR = 1.0), smoking-adjusted odds ratios (ever/never) were calculated for the remaining categories (Table 14). Although there are several categories with elevated odds ratios, only the odds ratio for the clerical category (1.57) is significant. The odds ratio for the service category (1.57) is similarly increased, and of borderline statistical significance.

Table 12. Adjusted[a] odds ratios for usual occupation in Texas male lung cancer study, 1976–1980

Occupation category	Total number in category (cases and controls)	Odds ratio	Confidence interval	χ^2
Clerical/Sales	94	0.61	0.36, 1.04	3.33
Service	50	1.12	0.60, 2.09	0.13
Agriculture	39	0.89	0.44, 1.84	0.09
Processing	77	0.80	0.47, 1.38	0.63
Machine trades	77	1.37	0.78, 2.39	1.19
Bench work	14	1.04	0.34, 3.19	0 0.
Structural work	275	1.46	0.96, 2.20	3.15
Miscellaneous	140	0.89	0.55, 1.44	0.22
Professional/Technical	157	1.00	— —	—

[a]Adjusted for smoking (ever/never).

of the Board of Regents and its Advisory Committee on Research and Development, we thank these individuals for their contributions not only to the R&D Program but also to the continued advancement of knowledge in this state.

Priscilla Kilcrease, PhD, Director
Research and Development Program
Louisiana Board of Regents

The Board of Directors and staff of the Cancer Association of Louisiana, Inc, and the Cancer Association of Greater New Orleans, Inc, a United Way agency, are very proud to have been involved in the planning and coordination of the International Lung Cancer Update Conference held March 3-5, 1983.

Many of the papers presented in the monograph reviewed the smoking habits and the epidemiologic trends in lung cancer incidence and mortality in the United States, Europe, and Japan. They all repeatedly emphasized the importance of cigarette smoking as the major causative factor in lung cancer.

Environmental hazards (eg, air pollution and asbestos) and host factors (eg, genetics and nutrition) play a small role in the overall etiology of lung cancer. The most important conclusion of the International Lung Cancer Update Conference is that an international emphasis should be placed on smoking cessation programs aimed not only at high-risk adult populations but more importantly at all adolescents.

The only rational approach is to prevent lung cancer by getting individuals to either stop smoking or never to start to smoke cigarettes.

Robert G. Weilbaecher, MD, President
Cancer Association of Greater New Orleans, Inc
Cancer Association of Louisiana, Inc

With the high incidence of lung cancer in Louisiana, it was very appropriate for New Orleans to be selected as the host city for the International Lung Cancer Update Conference. The Cancer Association of Louisiana and the Cancer Association of Greater New Orleans are glad to cosponsor a conference that brings together some of the world's lung cancer experts.

Personally, I have appreciated the opportunity to be involved in a program that could help resolve some of the health problems of Louisiana's citizens.

Ruth A. Sherwood, Executive Director
Cancer Association of Greater New Orleans, Inc
Cancer Association of Louisiana, Inc

Table 15. Adjusted* odds ratios for usual industry of employment in Texas female lung cancer study, 1976–1980

Industry category	Total number in category	Odds ratio	Confidence interval	χ^2
Agriculture	6	0.91	0.24, 3.53	0.02
Oil/gas extract	4	2.01	0.37, 10.84	0.66
Other mining	0	—	— —	—
Construction	2	4.95	0.75, 32.69	2.76
Chemical	2	3.93	0.40, 39.06	1.37
Petroleum	6	0.43	0.91, 2.00	1.16
Metals	2	3.93	0.40, 39.06	1.37
Shipbuilding	2	3.93	0.40, 39.06	1.37
Other manufacturing	23	2.70	0.95, 7.67	3.50
Transportation	12	0.78	0.22, 2.76	0.15
Services	74	1.26	0.75, 2.13	0.75
Professional/Governmental	93	1.08	0.69, 1.69	0.12
Sales	113	1.23	0.80, 1.90	0.92
Housewife	592	1.00	— —	—

*Adjusted for smoking (ever/never)

Table 16. Odds ratios for household member regularly employed in specific industry for Texas lung cancer study, 1976–1980: Males

Industry	Yes: Case	Yes: Control	Odds ratio	95% Confidence interval	χ^2
Asbestos manufacturing	6	2	2.60	0.60, 11.25	1.76
Cement manufacturing	5	5	0.99	0.30, 3.25	0.00
Insulation manufacturing	4	1	2.99	0.47, 19.04	1.48
Coal mining	11	4	2.57	0.86, 7.71	3.06
Shipyard/shipbuilding	58	52	1.11	0.75, 1.65	2.27
Demolition	5	3	1.54	0.40, 5.93	0.41
High-rise construction	11	9	1.19	0.50, 2.84	0.16

Table 17. Odds ratios for household member regularly employed in specific industry for Texas lung cancer study, 1976–1980: Females

Industry	Yes: Case	Yes: Control	Odds ratio	95% Confidence interval	χ^2
Asbestos manufacturing	5	10	0.55	0.20, 1.50	1.29
Cement manufacturing	20	18	1.17	0.02, 2.23	0.24
Insulation manufacturing	9	4	2.24	0.73, 6.94	2.07
Coal mining	7	12	0.63	0.25, 1.57	1.00
Shipyard/shipbuilding	99	102	1.02	0.75, 1.39	0.02
Demolition	5	7	0.77	0.25, 2.33	0.02
High-rise construction	37	26	1.52	0.91, 2.55	2.60

In addition to these analyses specific questions were asked regarding whether anyone in the household ever worked in the following industries: asbestos, cement, or insulation manufacturing; coal mining; shipyards and shipbuilding; demolition;

Table 8. Odds ratios associated with passive smoking

Ever live with household member who smoked	Number	Odds ratio	Confidence interval	χ^2
Males				
Total nonsmokers	61	0.52	0.15, 1.74	1.2
0–32 years	49	0.40	0.10, 1.58	1.8
33+ years	10	1.56	0.30, 8.05	0.3
Females				
Total nonsmokers	201	0.78	0.34, 1.81	0.3
0–32 years	97	0.62	0.24, 1.63	0.9
33+ years	99	0.93	0.38, 2.28	0.0

Histologic types of lung cancer were classified according to the World Health Organization (WHO) classification (10). The four major cell types account for 75–85% of the cases in both the male and female series and the cell type distribution by age group is shown for males and females in Table 9. Adenocarcinoma is the predominant lung cancer cell type in both young (30–49 years) males and females, comprising 37.8% (males) and 38.9% (females) of all lung cancers among persons aged 30–49 years at diagnosis. There is a marked shift with age in this pattern such that for both males and females aged 70 or older at diagnosis the predominant cell type is squamous or epidermoid (accounting for 40.5% of all cases among males and 31.0% among females). Overall, squamous was the predominant cell type among males (42.2%) and adenocarcinoma among females (35.5%). These patterns held for both smokers and nonsmokers except for nonsmoking males, in whom 6 of 11 (54.5%) cases were adenocarcinoma.

The risk associated with smoking was examined by cell type, specifically odds ratios for smoking categories within the adenocarcinoma series compared with nonadenocarcinoma cases (Tables 10 and 11). The odds ratios for smoking categories based on pack-years were all significant, emphasizing the increased risk of lung cancer (all types) associated with smoking. However, the gradient of risk, in both males and females, was markedly different for adenocarcinoma compared with nonadenocarcinoma (all other lung cancer) cell types. There were 104 cases of

Table 9. Male and female lung cancer cases by histologic type and age, Texas, 1976–1980

	Males						Females					
	30–49 years		50–69 years		70+ years		30–49 years		50–69 years		70+ years	
Cell type	No	%	No	%	No	%	No	%	No	%	No	%
Squamous	8	21.6	112	34.8	47	40.5	11	20.4	74	22.6	22	31.[illegible]
Small cell	4	10.8	64	20.1	16	13.8	10	18.5	92	28.1	11	15.[illegible]
Adenocarcinoma	14	37.8	73	22.9	17	14.7	21	38.9	99	30.3	19	26.[illegible]
Large cell	2	5.4	19	6.0	9	7.8	4	7.4	11	3.4	3	4.[illegible]
Other		24.4		16.2		23.2		14.8		15.7		12.[illegible]
Total		100.0		100.0		100.0		100.0		100.0		100.[illegible]

were contacted and asked to participate in the study. Population-based and decedent comparison subjects were selected from state and federal records and matched to cases on age, race, sex, vital status at time of ascertainment, and county of residence (Harris County or other five counties). Hispanic study subjects were identified systematically by use of an algorithm to identify Spanish surname. Medical records were abstracted by state-trained abstractors to obtain relevant disease and demographic data. Following contact with the family physician (for cases only), personal interviews were conducted with study subjects or with the next of kin of decedent cases and comparison subjects, using established criteria for selecting the most appropriate next of kin respondents. Interviews were conducted by trained interviewers in the home using a standardized interview protocol. Detailed information regarding the primary exposures of interest was collected, specifically smoking history, work history, residential history, and drinking history.

Industries of employment were coded to the Standard Industrial Classification (SIC) (6) and occupations were coded using the *Dictionary of Occupational Titles* (7). The Mantel-Haenszel summary chi-square and odds ratio statistics were calculated (8). Confidence intervals (95%) were calculated using the method of Miettinem (9).

Results

A total of 56 of the 67 hospitals in the six-county Texas study participated in the study, including all of the seven large hospitals (500 or more beds). Ten of the 11 smaller hospitals that did not participate were located in Harris County. Therefore we were able to ascertain 92.2% (1520 cases) of the total 1649 incident white male and female lung cancer cases (including Hispanic) estimated for the 3- to 4-year interval (mid-1976 or 1977 to mid-1980). The number of incident cases was estimated by adjusting age–race–sex–county mortality rates by population growth and an incidence: mortality ratio of 1.35:1.0. Case ascertainment was higher for residents of counties other than Harris County, 97.2% vs 82.1% (Table 1). A total of 766 female and 754 male cases were ascertained representing, respectively, 88.7 and 96.1% of the total estimated incident cases ascertained Hispanic females appear to be poorly ascertained (38.1%), but this may be related to the classification based on Spanish surname which may not be an effective technique for ascertaining married Hispanic females.

All ascertained cases will be used for determining age–race–sex and county lung cancer incidence rates for the study area. A total of 88.9% of the ascertained cases were included in the interview study. Some cases (110, or 7.2%) lacked histologic or cytologic confirmation of lung cancer and were ineligible for the case-comparison study. For the majority of these cases (79, or 71.8%) the basis of the lung cancer diagnosis was radiologic or clinical evidence. There was insufficient diagnostic information available on the remaining 31 cases. Additional losses of study subjects in the case-comparison study were related to race and residential eligibility criteria; unable to locate; moved out of interview area; physician,

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Table 13. Adjusted[a] odds ratios for usual industry of employment in Texas male lung cancer study, 1976–1980

Industry category (SIC number)	Total number in category	Odds ratio	Confidence interval	χ^2
Agriculture (01–09)	30	1.64	0.70, 3.83	1.31
Oil/gas extract (13)	28	2.44	1.00, 5.97	3.82
Other mining (10–12, 14)	8	0.72	0.19, 2.80	0.22
Construction (15–17)	150	2.56[b]	1.49, 4.41	11.50
Chemical (28)	60	2.16[b]	1.10, 4.24	5.04
Petroleum (29)	178	1.54	0.91, 2.60	2.63
Metals (33–34)	25	3.38[b]	1.36, 8.39	6.90
Shipbuilding (373)	27	1.91	0.83, 4.42	2.29
Other manufacturing (20–39 minus above)	52	1.55	0.77, 3.12	1.51
Transportation (40–49)	120	2.57[b]	1.47, 4.52	10.88
Personal services (60–69, 80, 91–97)	65	1.73	0.91, 3.29	2.76
Professional/Governmental (70–79, 81–87)	85	1.34	0.73, 2.44	0.91
Sales (50–59)	97	1.00	— —	—

[a] Adjusted for smoking (ever/never).
[b] $p < .05$

Table 14. Adjusted[a] odds ratios for usual occupation in Texas female lung cancer study, 1976–1980

Occupation category	Total number in category	Odds ratio	Confidence interval	χ^2
Clerical	161	1.57[b]	1.07, 2.31	5.27
Service	88	1.57	0.96, 2.57	3.22
Agriculture	3	0.74	0.14, 3.92	0.12
Processing	2	4.22	0.43, 41.33	1.53
Machine trades	2	2.66	0.45, 15.93	1.15
Bench work	11	1.67	0.47, 5.97	0.62
Structural	2	5.22	0.79, 34.59	2.93
Miscellaneous	8	2.27	0.52, 9.98	1.18
Professional/Technical	110	1.15	0.75, 1.76	0.40
Housewife	551	1.00	— —	—

[a] Adjusted for smoking (ever/never).
[b] $p < .05$

There were too few observations in the remaining categories for a meaningful analysis. A similar analysis of usual industry of employment for females indicated no categories of concern except for the possible exception of the increase noted for the category of other manufacturing (Table 15).

Smoking-adjusted odds ratios were also examined for the usual occupation and industry of employment for the spouses of both males and females. The only significantly increased odds ratio observed was for the usual industry of employment for spouses of female lung cancer cases. The Construction industry, with 146 cases and controls reporting this as the usual industry for their spouse, was associated with an increased odds ratio of 1.74 (1.04, 2.92; $\chi^2 = 4.40$).

Table 6. Odds ratios* associated with smoking variables for males and females, Texas lung cancer study, 1976–1980

	Males	Females
Ever smoked	10.12	6.89
Current smoker	9.59	7.89
Ex-smoker	10.85	5.00
Pack-years		
Low (0–35)	6.24	3.21
Moderate (36–63)	9.39	7.98
High (64 +)	13.05	13.35
Filtered cigarettes		
Yes	9.39	7.11
No	10.25	6.06
Both	12.27	7.09

*All odds ratios significant at $p < .05$

male and female study groups into smokers (ever) and nonsmokers (never) and examining the adjusted odds ratios, there was no significant increase in risk associated with passive smoking. In fact, the odds ratios for nonsmokers living with a regular smoker were not increased for either males or females, 0.52 and 0.78, respectively. However, odds ratios for smokers living with a regular smoker were increased, although not significantly, 1.28 and 1.80 for males and females. The overall odds ratios (adjusted) associated with passive smoking were only slightly increased and not significant for either males or females, 1.2 and 1.3, respectively. When the possibility of a "passive smoking" effect was examined among nonsmokers by number of years lived with a regular smoker, there was very little difference in risk for females who lived with a regular smoker for 0-32 years (Table 8). The odds ratios for males suggest an increase by are based on smaller numbers than the analysis in females.

Table 7. Odds ratios for passive smoking (household member smoked regularly) in Texas male and female lung cancer studies, 1976–1980

	Yes		No		Odds	95%	
	Case	Control	Case	Control	ratio	Confidence interval	χ^2
Males							
Crude	363	329	93	119	1.41*	1.04, 1.92	4.8
Self ever smoked							
No	5	56	6	34	0.52	0.15, 1.74	1.2
Yes	357	273	87	85	1.28	0.91, 1.79	2.0
Overall (MOR)					1.20	0.87, 1.65	1.18
Females							
Crude	429	425	24	51	2.12*	1.29, 3.50	9.05
Self ever smoked							
No	33	164	8	32	0.78	0.34, 1.81	0.3
Yes	396	260	16	19	1.80	0.92, 3.58	3.0
Overall (MOR)					1.30	0.78, 2.18	1.0

*$p < .05$.

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60% of the cases and controls was "Housewife." We will employ a number of more specific designations of occupational and industrial variables in future analyses.

Even with these recognized limitations, the suggestion which clearly emerges from our data is that there may be a wider variety of workplace exposures associated with substantial increments in the risk of lung cancer than currently recognized. In addition, use of the full work history, including dates will surely aid in refining the preliminary associations reported here.

The relationship of lung cancer cell type with age at time of diagnosis warrants further scrutiny in that the highest odds ratios for the smoking variables were observed for the youngest age group (< 57 years at time of diagnosis). The lack of a "passive smoking" effect when the confounding effect of smoking of individual study subjects is considered, is not consistent with early reports. Although subsequent reports are also not consistent with regard to this association, it may be that the study population available was not sufficiently large to detect a fairly low level effect and that this association needs to be assessed in a considerably larger study population.

These preliminary analyses demonstrate a strong and consistent smoking effect in males and females for all types of lung cancer. The risk differentials associated with cigarette smoking observed for adenocarcinoma and other lung cancer cell types are striking and consistent with findings of others (11). In addition, they reemphasize earlier suggestions that perhaps specific environmental exposures are more strongly associated with specific types of lung cancer. In addition, these data suggest that perhaps lung cancer is more similar in males and females than previously regarded and that the observed differentials in risk by sex are principally due to exposure differentials.

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Table 10. Odds ratios associated with smoking for lung cancer cell types in males, Texas lung cancer study, 1976–1980

Cell type	Smoking category (pack-years)	Odds ratio	Confidence intervals	χ^2
Adenocarcinoma	Low	3.85	1.44, 10.31	8.04
	Moderate	4.45	1.72, 11.48	10.93
	High	5.38	2.14, 13.56	15.21
Nonadenocarcinoma	Low	6.60	2.75, 15.84	21.57
	Moderate	11.30	4.87, 26.19	43.75
	High	15.41	6.73, 35.25	63.34

Table 11. Odds ratios associated with smoking for lung cancer cell types in females, Texas lung cancer study, 1976–1980

Cell type	Smoking category (pack-years)	Odds ratio	Confidence intervals	χ^2
Adenocarcinoma	Low	2.16	1.18, 3.98	6.37
	Moderate	4.32	2.40, 7.79	26.11
	High	7.80	4.28, 14.20	52.93
Nonadenocarcinoma	Low	4.17	2.34, 7.43	25.80
	Moderate	10.97	6.27, 19.20	86.87
	High	18.90	10.61, 33.67	128.13

adenocarcinoma in the male series and 139 in the female series. A much steeper increase in risk associated with lifetime cigarette dose (pack-years) is observed for all other lung cancer cell types compared to adenocarcinoma. These patterns are summarized in Figure 5.

Preliminary analyses of the detailed work histories is based on the usual occupation and usual industry of employment as reported or as summarized from the work history for self and spouse. Examination of the work histories indicates that approximately 78% of the study subjects spent more than half of their reported working time employed in the occupation reported as their usual occupation. Usual industry of employment was determined by selecting the industry in which a subject was reported to have been employed for the longest duration of time. Odds ratios, adjusted for smoking (ever/never) were determined to identify whether an increased risk was associated with employment in a given occupation or industry for both males and females. Using the Professional/Technical category as a referent for males (odds ratio = 1), none of the odds ratios for the other occupational categories was significantly increased (Table 12). Odds ratios (OR) for usual industry of employment were similarly calculated using the sales category (SIC 50–59) as the referent (OR = 1.0) (Table 13). Significantly elevated odds ratios were observed for several industrial categories, specifically construction (SIC 15–17), chemical manufacturing (SIC 28), metal manufacturing (SIC 33–34), and transportation (SIC 40–49). In addition, an elevated odds ratio (OR = 2.44) of borderline statistical significance (at the .05 level) is observed for oil and gas extraction (SIC 13).

high-rise construction. For both males and females a large number of cases and controls reported having a household member employed in a shipyard or in shipbuilding, but this was not associated with an increased odds ratio (1.11 for males and 1.02 for females) (Tables 16 and 17). Among males there were no statistically significant increases; however, the odds ratios for asbestos manufacturing, insulation manufacturing, and coal mining are increased. Similarly, for females the odds ratio is increased for insulation manufacturing and high-rise construction but not significantly.

Discussion

The availability of fairly large numbers of male and female incident lung cancer cases and comparison subjects in an interview study with detailed occupational histories provides an important basis for examining the contribution of occupational exposures to lung cancer in males and females. Recognizing the strong increase in lung cancer risk associated with cigarette smoking, such analyses need to control for smoking differences. Our preliminary analysis of usual occupation and industry of employment with a broad smoking adjustment (ever/never) indicates several occupational and industrial associations that need to be pursued in future analyses. Specifically, odds ratios are significantly increased for usual employment in several industries (construction, chemical, metal, and transportation) for males and the clerical occupations for females. In addition, there are several associations suggested by increased odds ratios, which are not statistically significant. For males, an increased risk is suggested for occupations in the structural category and employment in industries related to oil and gas extraction (SIC 13), petroleum refining (SIC 60–69), and shipbuilding (SIC 373). For females, occupations in the service category and industries in the other manufacturing group are associated with fairly stable increased odds ratios.

Future analysis of these data will examine the possible interaction of smoking with occupational and industrial groups and a possible need to employ more specific smoking strata. Examination of odds ratios for smoking strata within occupational and industrial categories suggested that an ever/never smoking classification would be sufficient to control for the confounding effect of smoking in the examination of overall risks associated with usual employment in specific occupational and industrial categories as presented here. However, this broad classification may not be sufficiently specific for an examination of interaction of smoking with workplace exposures. In these analyses the classification of "exposed" within a specific category is based upon the "usual" occupation or industry of employment rather than "ever employed" in a given work environment. The use of the usual pattern may be more conservative in the detection of occupational and industrial associations and is perhaps the more appropriate designation to use for a preliminary examination of the data. As noted, the use of the usual occupation and industry of employment did introduce some special constraints on the analysis of the female patterns in that the usual occupation and industry for over

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